

Adsorption of n-Pentane on Mesoporous Silica and Adsorbent Deformation

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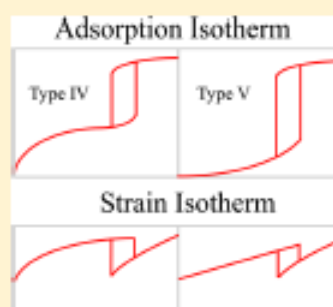
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ABSTRACT: Development of quantitative theory of adsorption-induced deformation is important, e.g., for enhanced coalbed methane recovery by CO₂ injection. It is also promising for the interpretation of experimental measurements of elastic properties of porous solids. We study deformation of mesoporous silica by n-pentane adsorption. The shape of experimental strain isotherms for this system differs from the shape predicted by thermodynamic theory of adsorption-induced deformation. We show that this difference can be attributed to the difference of disjoining pressure isotherm, responsible for the solid–fluid interactions. We suggest the disjoining pressure isotherm suitable for n-pentane adsorption on silica and derive the parameters for this isotherm from experimental data of n-pentane adsorption on nonporous silica. We use this isotherm in the formalism of macroscopic theory of adsorption-induced deformation of mesoporous materials, thus extending this theory for the case of weak solid–fluid interactions. We employ the extended theory to calculate solvation pressure and strain isotherms for SBA-15 and MCM-41 silica and compare it with experimental data obtained from small-angle X-ray scattering. Theoretical predictions for MCM-41 are in good agreement with the experiment, but for SBA-15 they are only qualitative. This deviation suggests that the elastic modulus of SBA-15 may change during pore filling.



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